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Naganuma et al.

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(54) **LIQUID EJECTING HEAD AND MANUFACTURING METHOD OF LIQUID EJECTING HEAD**

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(73) Assignee: **Seiko Epson Corporation**, Tokyo (JP)

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(30) **Foreign Application Priority Data**

Jun. 18, 2014 (JP) 2014-125059

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B41J 2/14 (2006.01)
B41J 2/16 (2006.01)

(52) **U.S. Cl.**
CPC ***B41J 2/14233*** (2013.01); ***B41J 2/161*** (2013.01); *B41J 2/14201* (2013.01); *B41J 2/1621* (2013.01); *B41J 2002/14306* (2013.01); *B41J 2002/14419* (2013.01); *Y10T 29/49403* (2015.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Workman Nydegger

(57) **ABSTRACT**

A liquid ejecting head includes a nozzle which ejects a liquid, a pressure chamber, a portion of which is partitioned by a flexible diaphragm and which communicates with the nozzle, a piezoelectric element which is laminated on an opposite side of the diaphragm from the pressure chamber and changes a pressure within the pressure chamber, and a reservoir which communicates with the pressure chamber, in which a valve mechanism is provided in a region which is distanced from a region in which the piezoelectric element of the diaphragm is laminated, and is configured to allow the liquid to flow from the reservoir side into the pressure chamber side while inhibiting the liquid from flowing out from the pressure chamber side to the reservoir side.

5 Claims, 14 Drawing Sheets

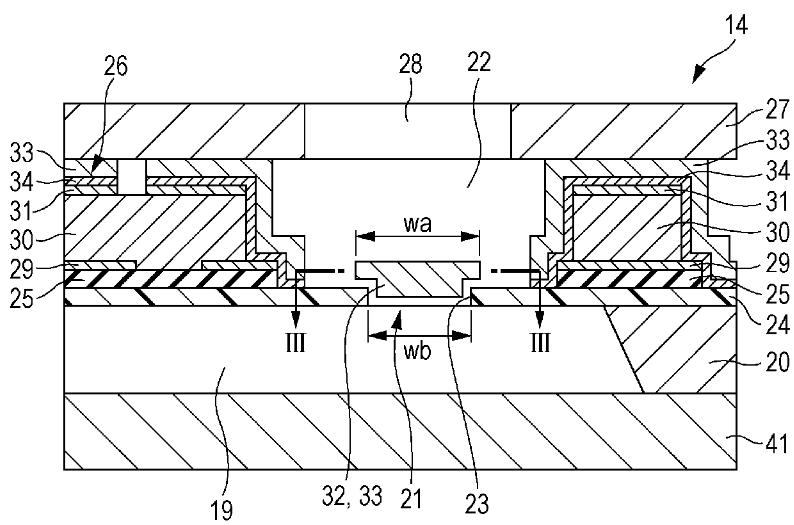

FIG. 1

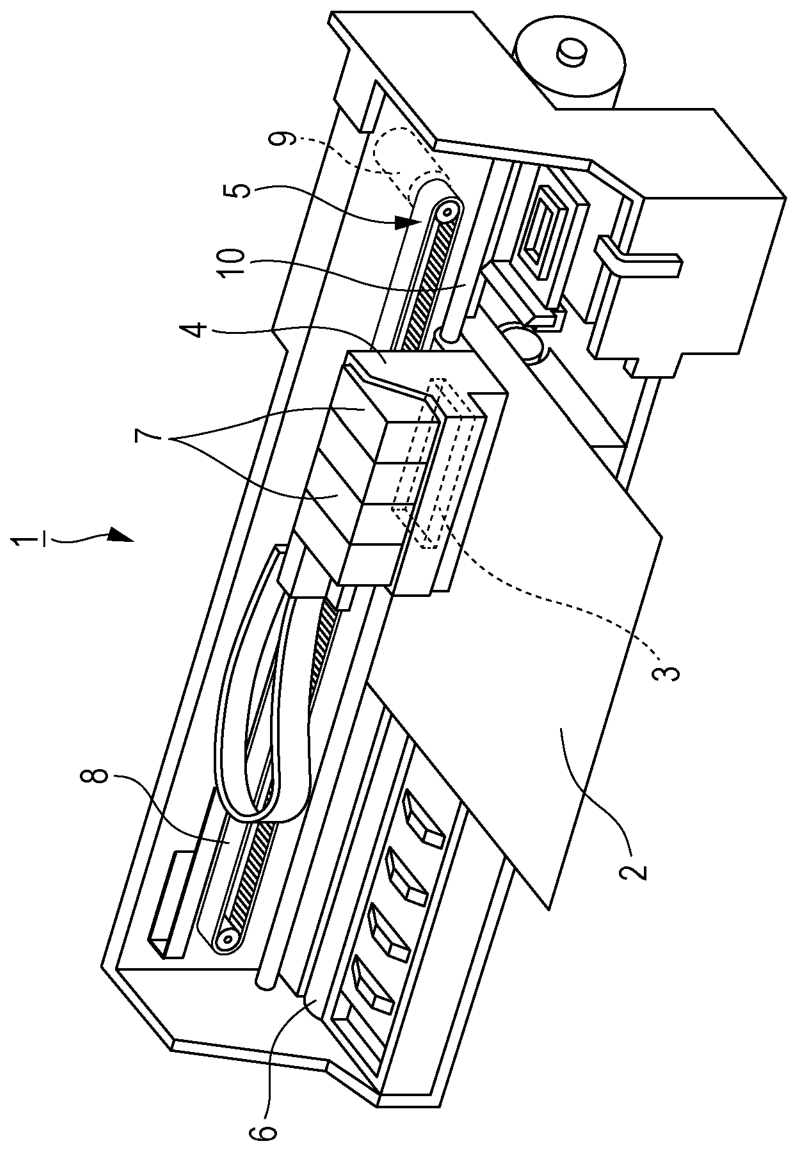

FIG. 2A

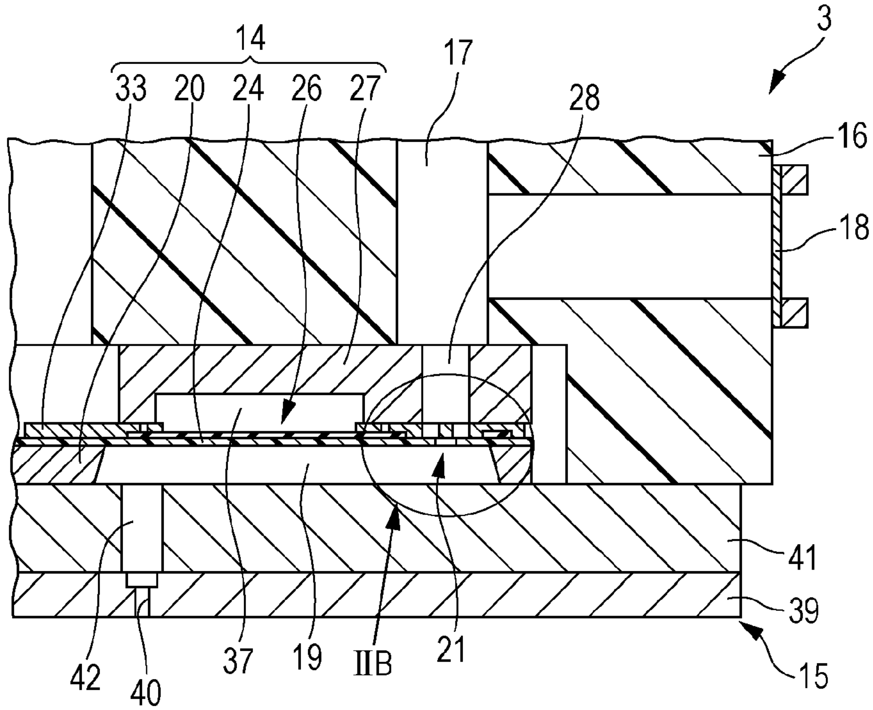
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FIG. 2B

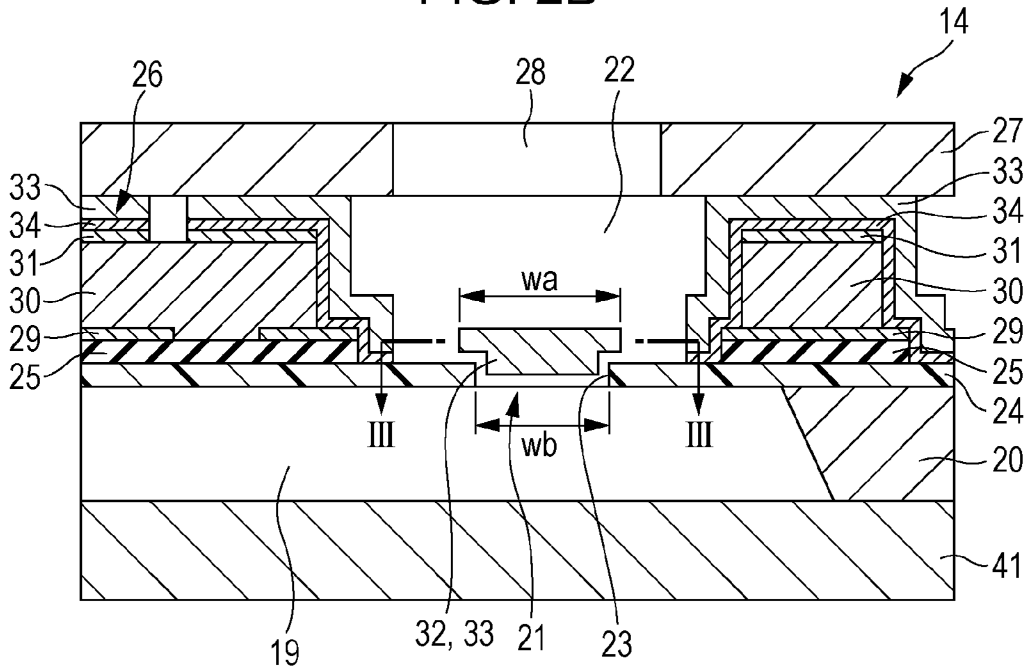
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FIG. 3

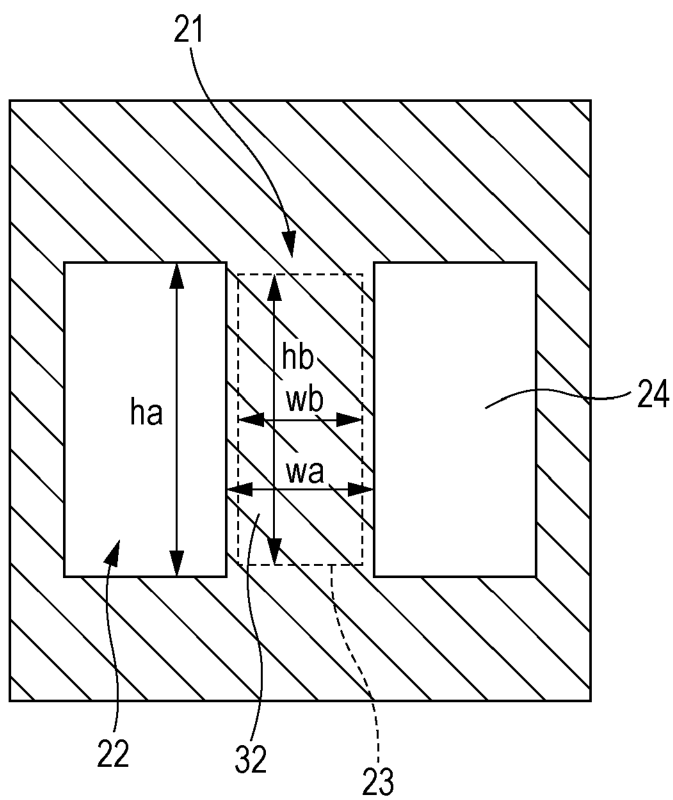

FIG. 4A

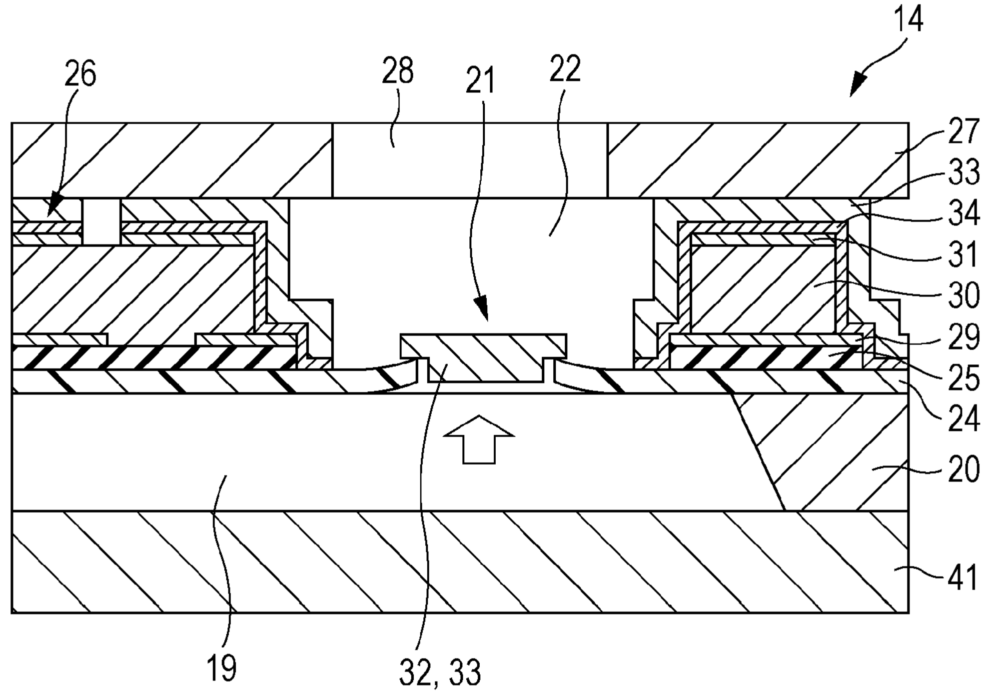
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FIG. 4B

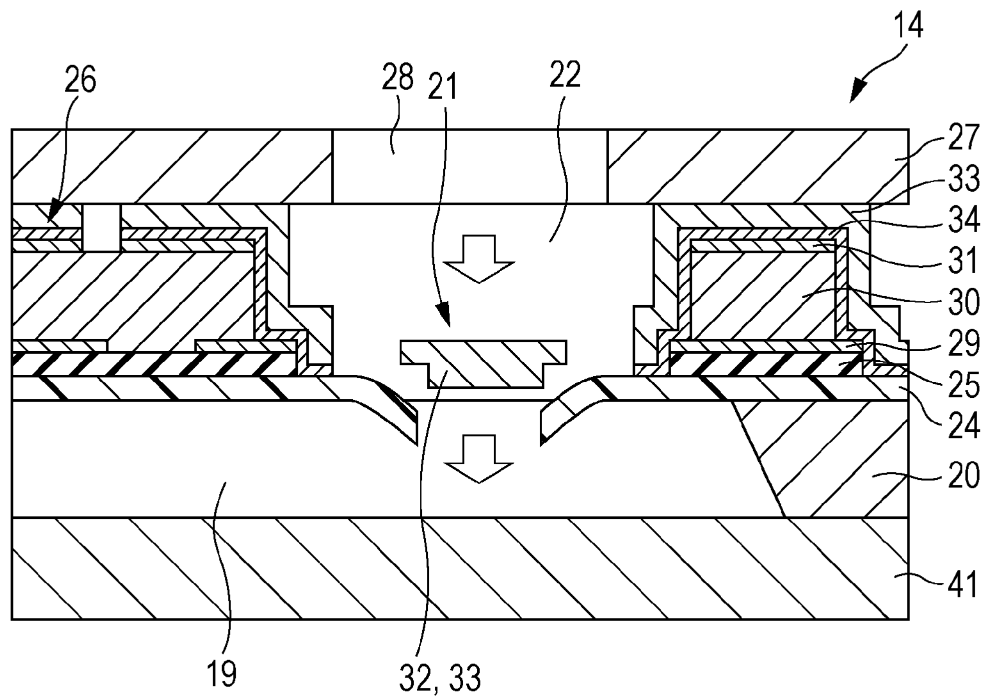
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FIG. 5A

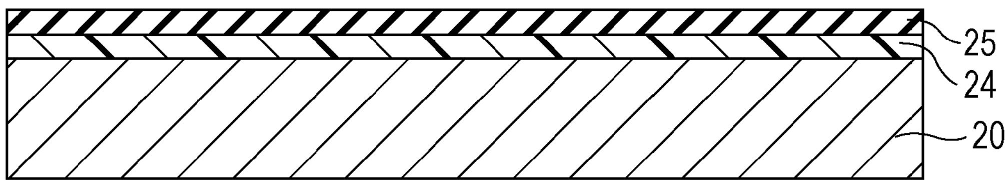

FIG. 5B

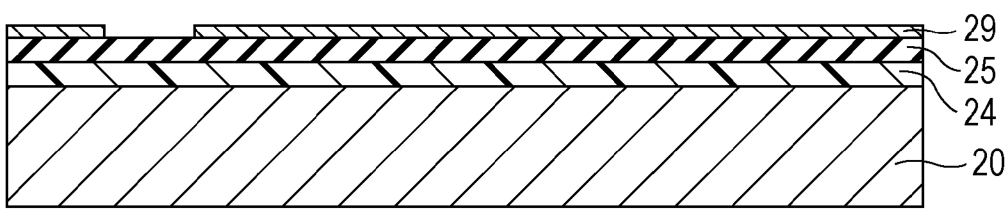

FIG. 5C

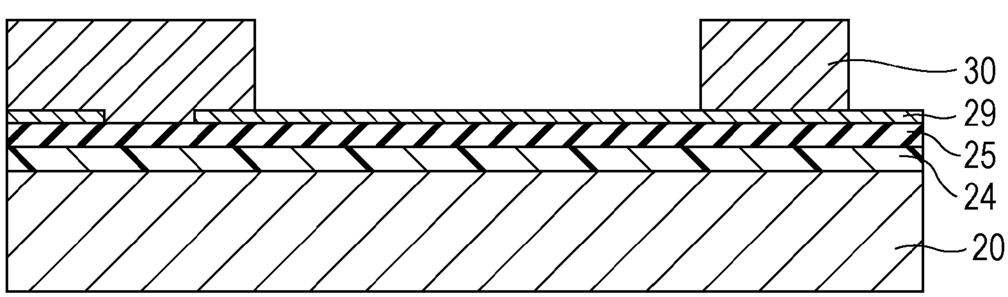

FIG. 6A

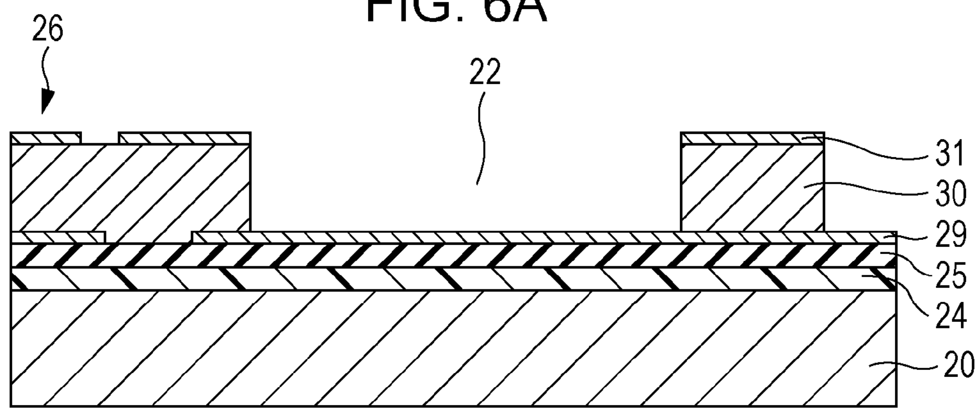

FIG. 6B

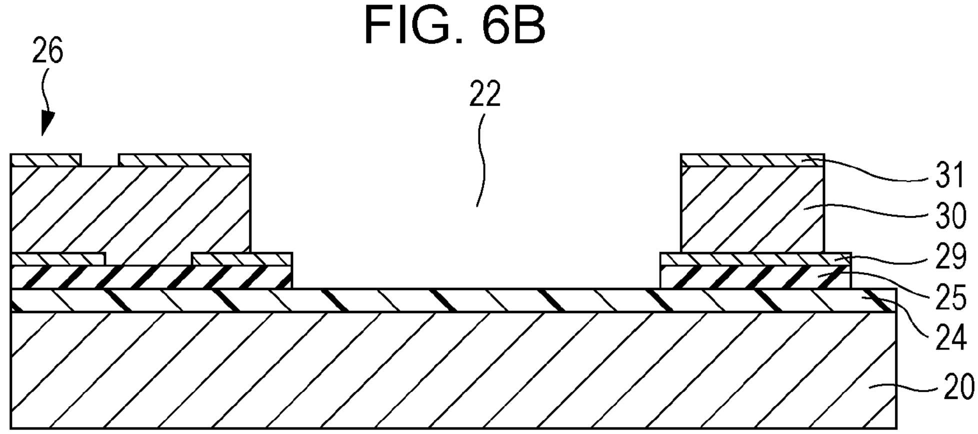

FIG. 6C

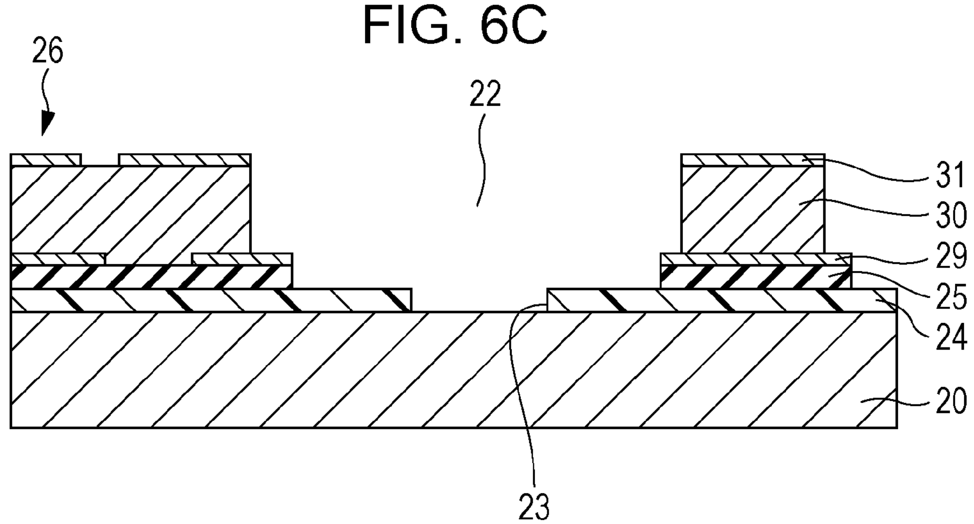

FIG. 7A

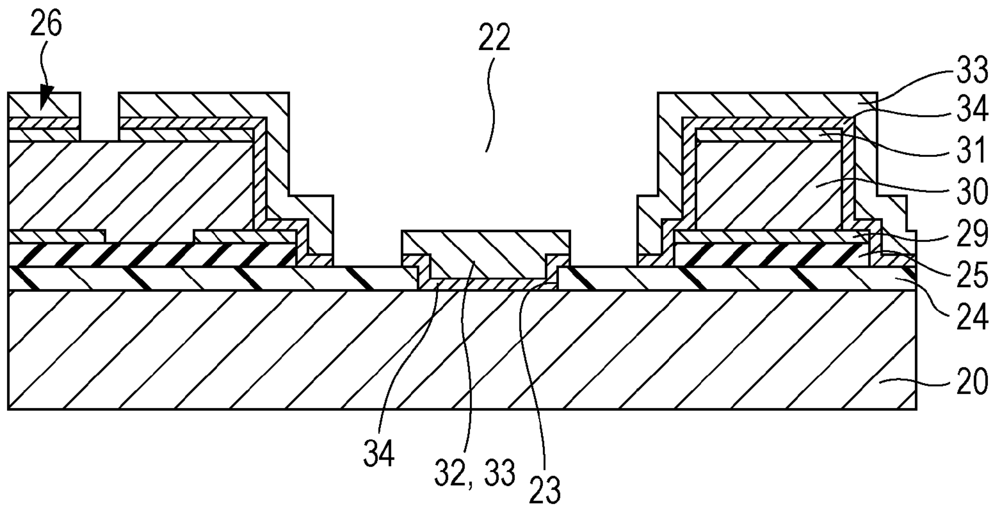
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FIG. 7B

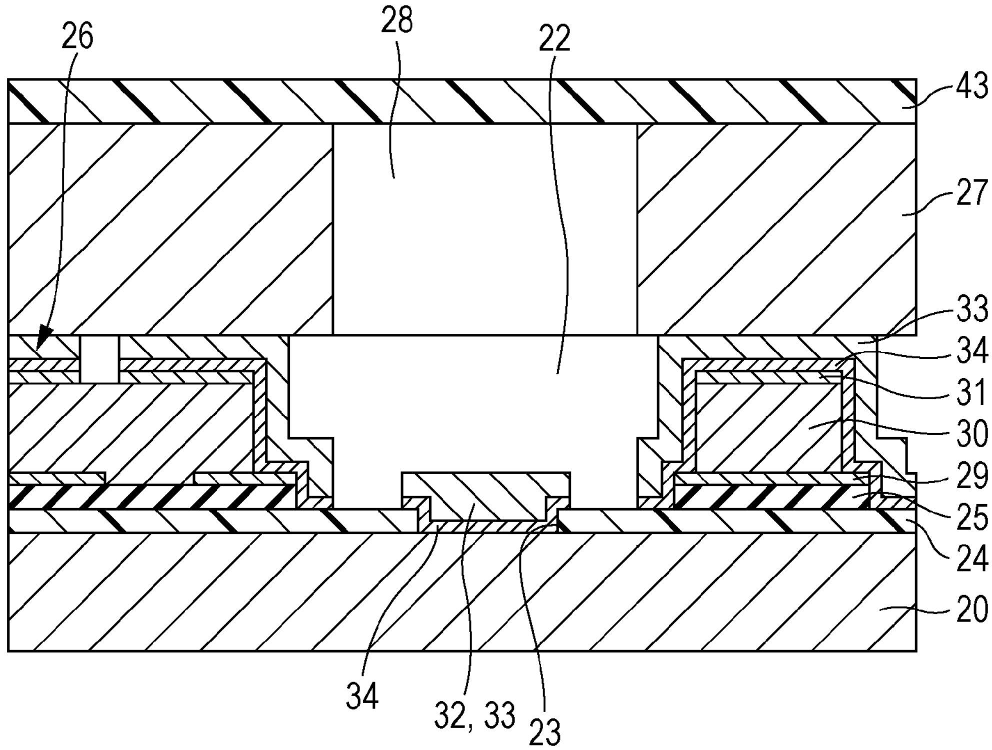
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FIG. 8A

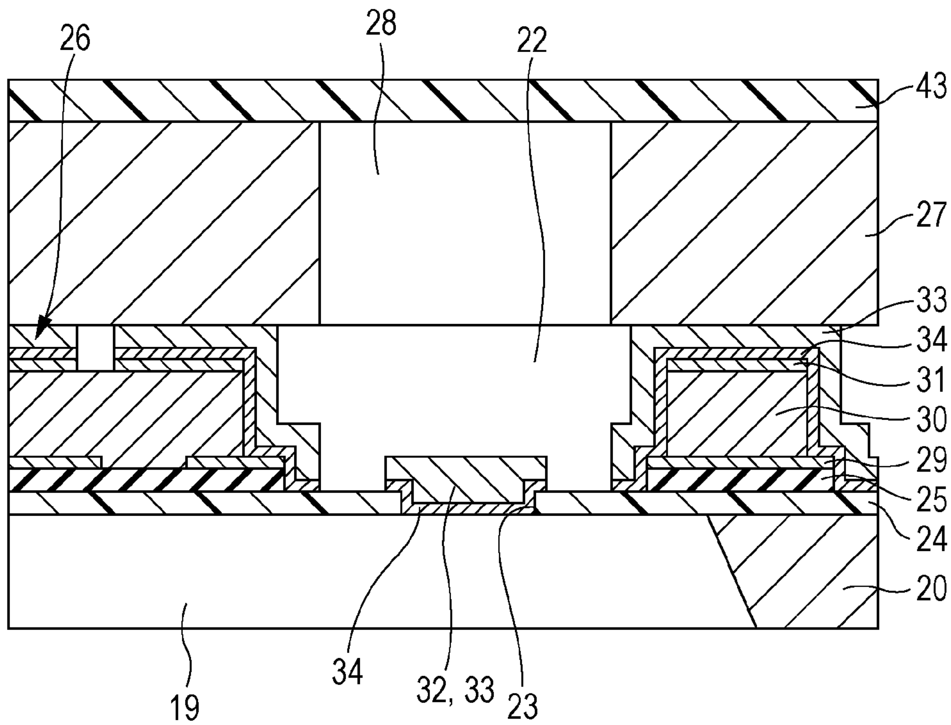
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FIG. 8B

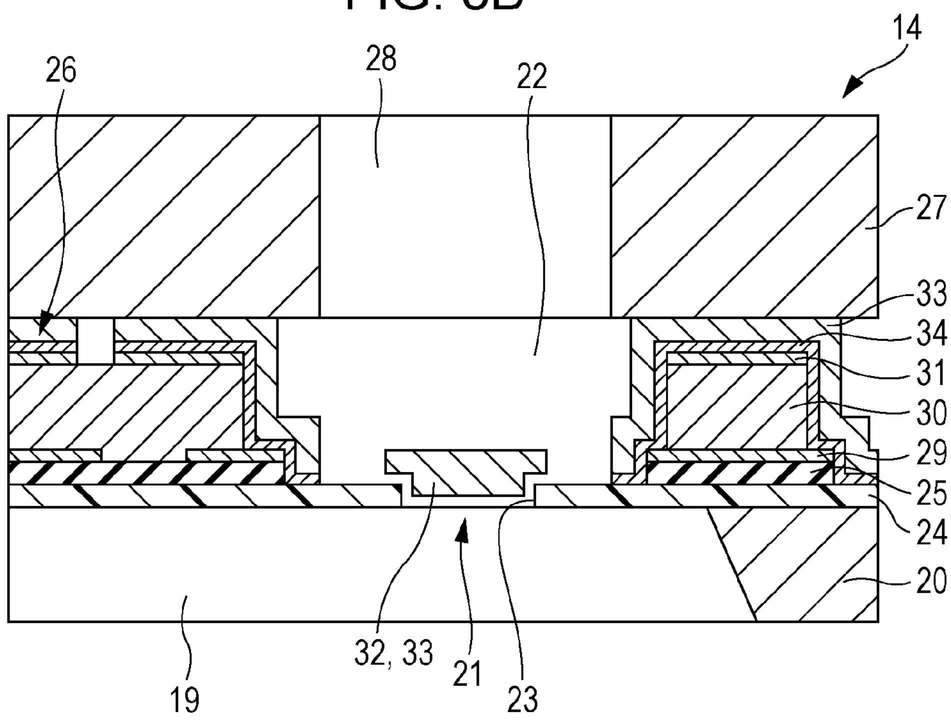
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FIG. 9A

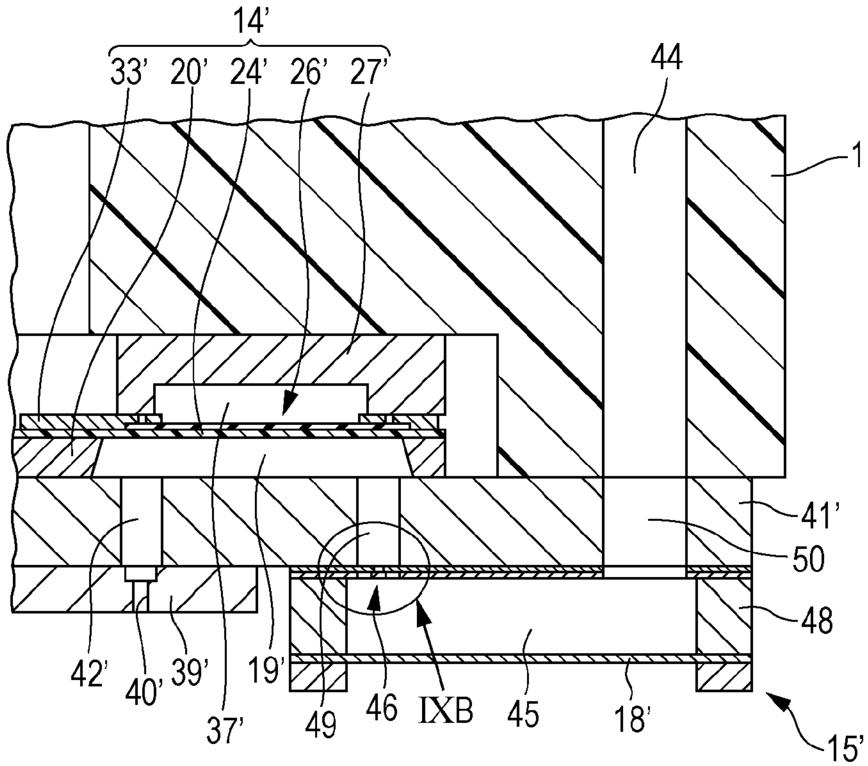
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FIG. 9B

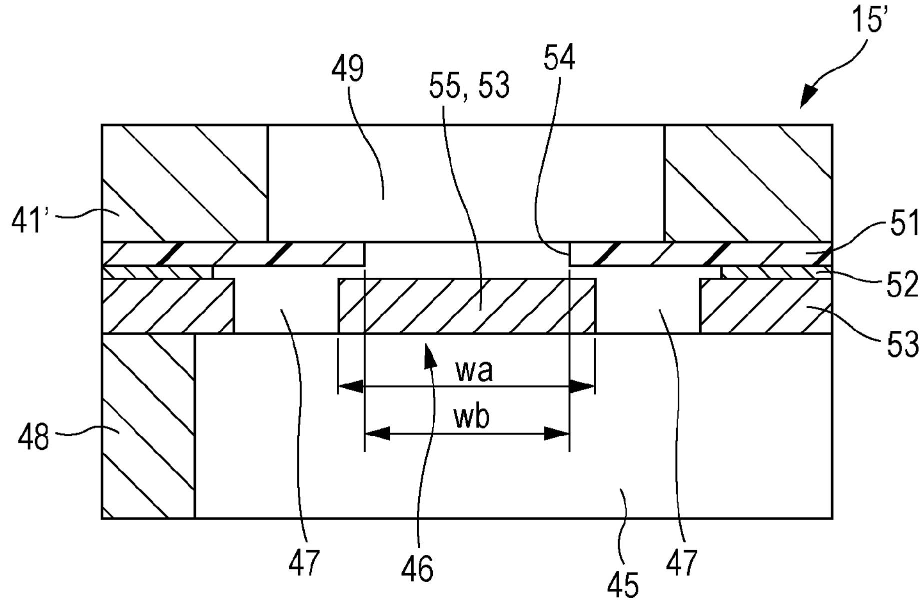
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FIG. 10A

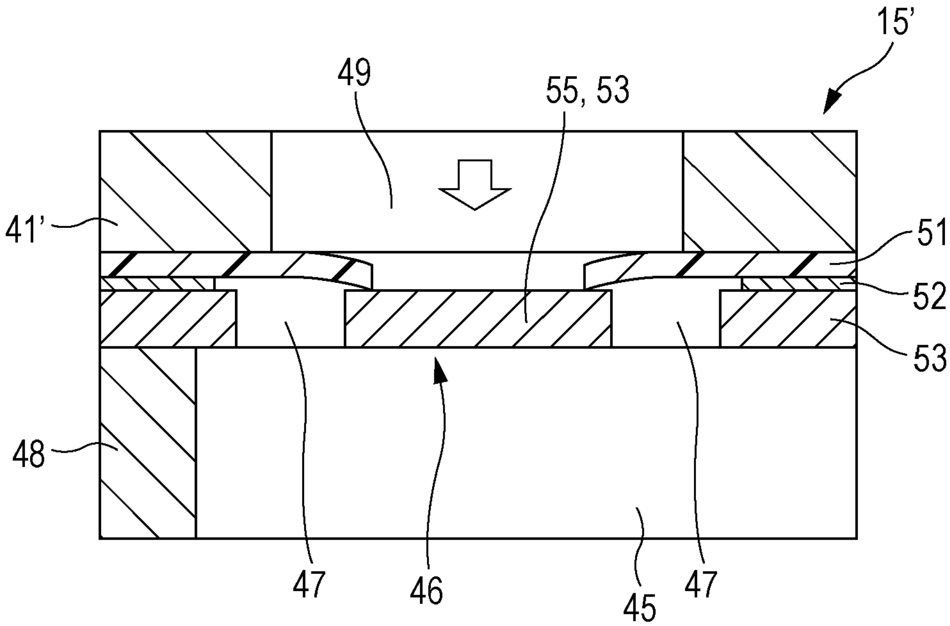

FIG. 10B

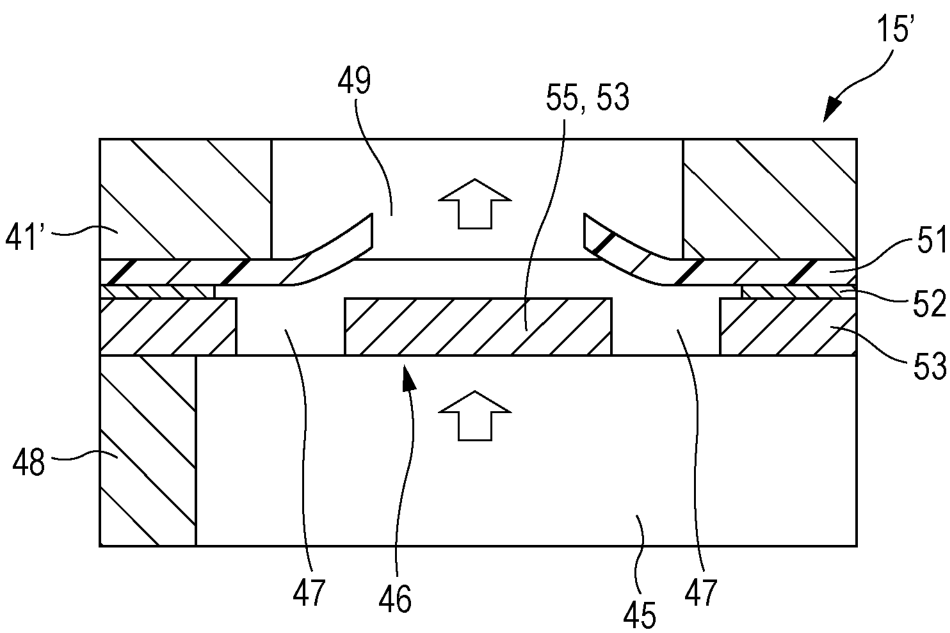

FIG. 11A

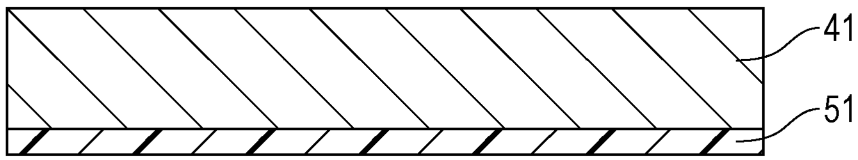

FIG. 11B

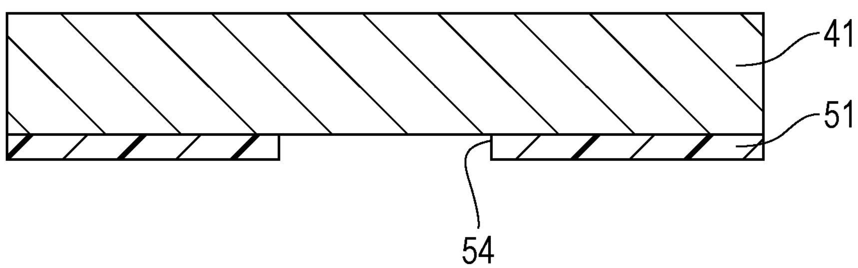

FIG. 11C

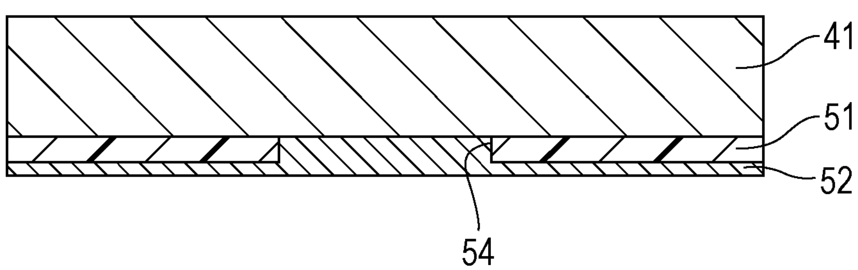

FIG. 12A

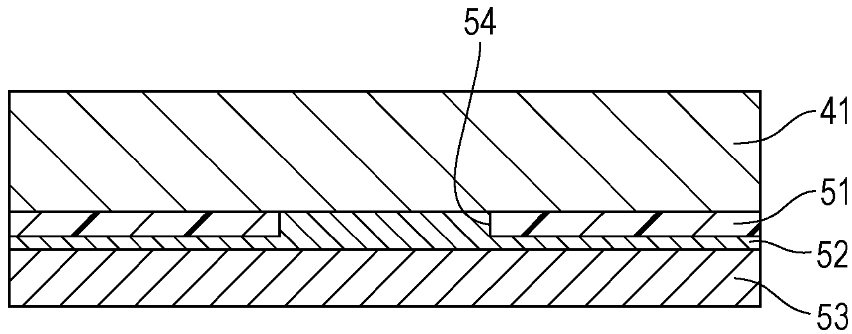

FIG. 12B

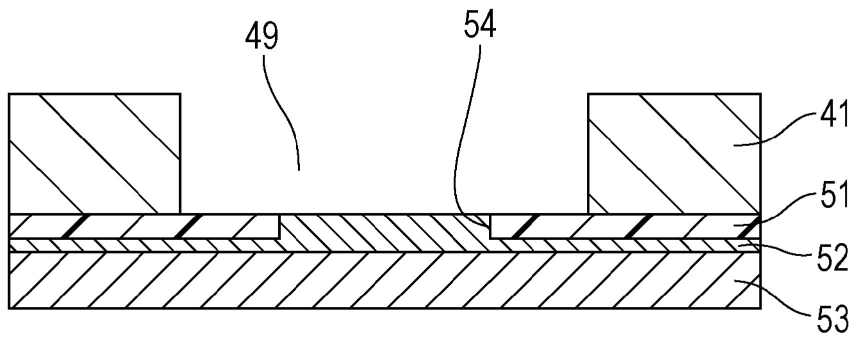

FIG. 12C

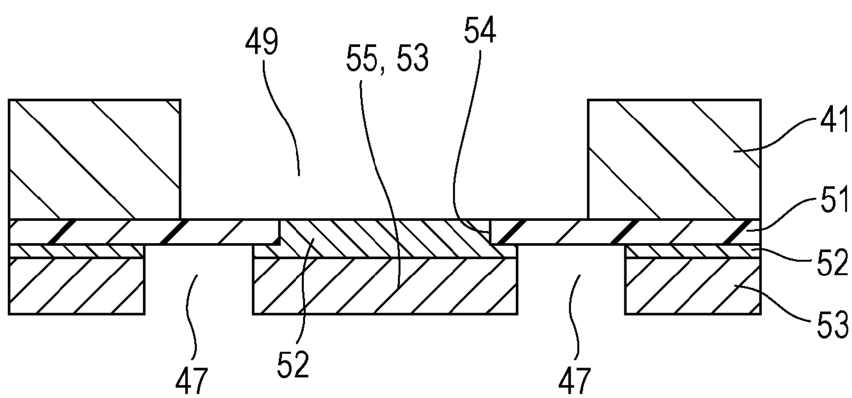

FIG. 13A

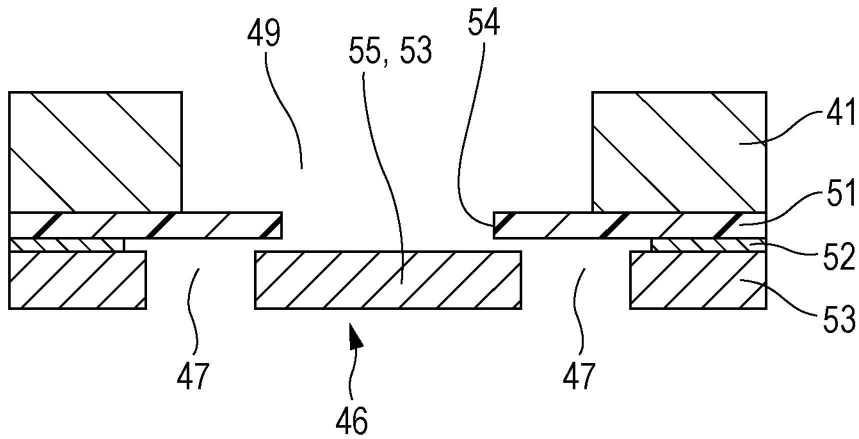

FIG. 13B

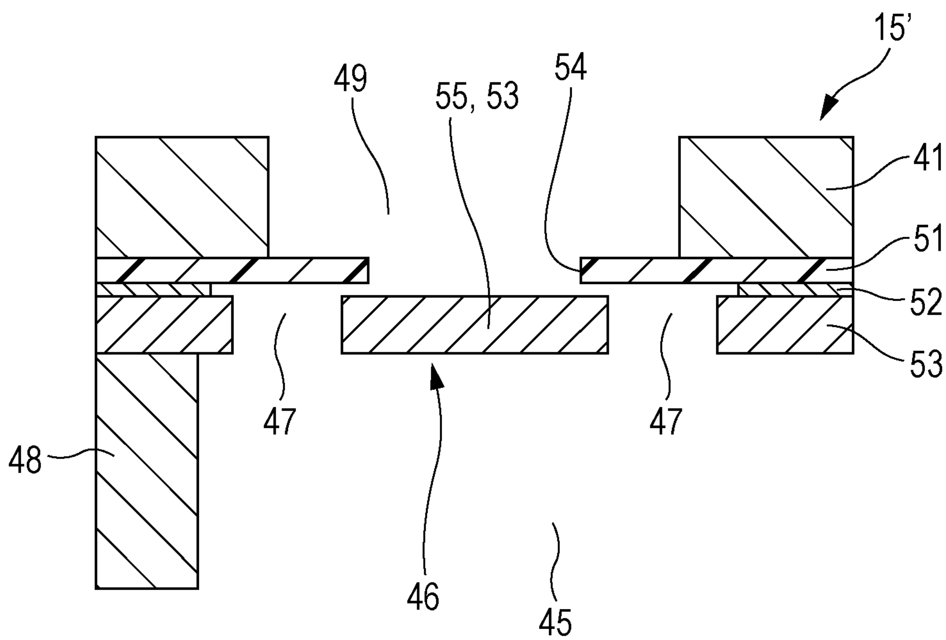

FIG. 14

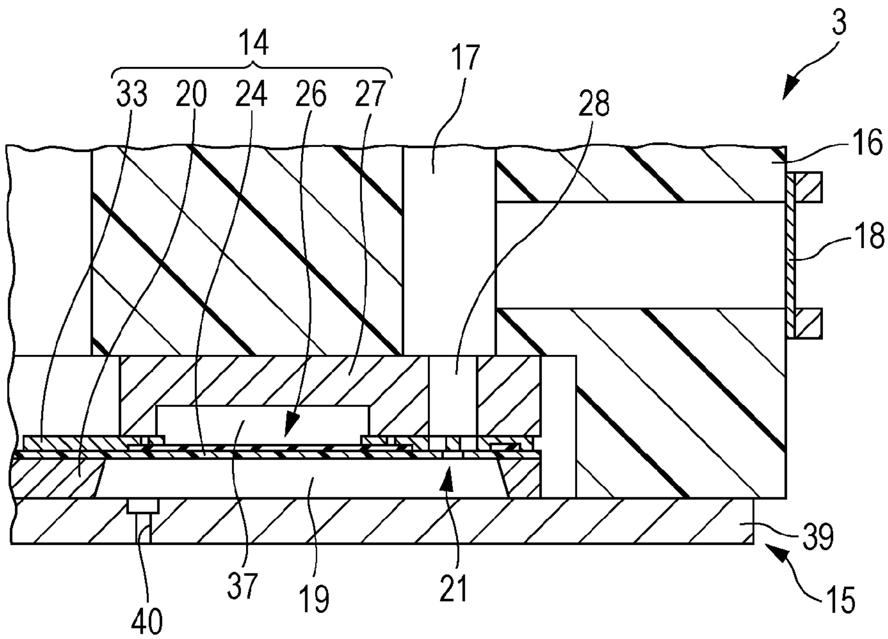
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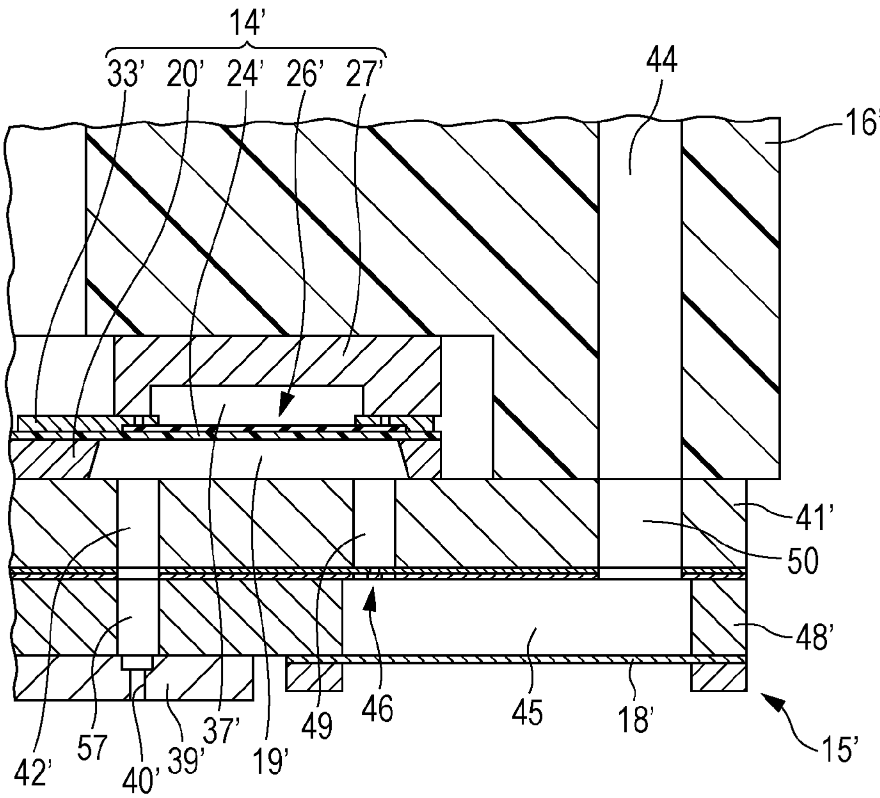
FIG. 15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LIQUID EJECTING HEAD AND MANUFACTURING METHOD OF LIQUID EJECTING HEAD

CROSS-REFERENCE TO RELATED APPLICATIONS

The entire disclosure of Japanese Patent Application No: 2014-125059, filed Jun. 18, 2014 is expressly incorporated by reference herein in its entirety.

BACKGROUND

1. Technical Field

The present invention relates to a liquid ejecting head which ejects a liquid within a pressure chamber from a nozzle which communicates with the pressure chamber, and a manufacturing method of the liquid ejecting head.

2. Related Art

A liquid ejecting apparatus is an apparatus which is provided with a liquid ejecting head and which ejects various liquids from an ejecting head. An image recording apparatus such as an ink jet printer or an ink jet plotter is an example of the liquid ejecting apparatus; however, recently liquid ejecting apparatuses are also being adapted for use in various manufacturing apparatuses, making use of the characteristic of being capable of causing minute amounts of a liquid to accurately land on predetermined positions. For example, the liquid ejecting apparatuses are being adapted for use in display manufacturing apparatuses which manufacture color filters of liquid crystal displays and the like, electrode forming apparatuses which form electrodes of organic electro-luminescence (EL) displays, face emission displays (FED), and the like, and chip manufacturing apparatuses which manufacture biochips (biochemical elements). In a recording head for an image recording apparatus, a liquid-state ink is ejected, and in a color material ejecting head for a display manufacturing apparatus, solutions of color materials for each of red (R), green (G), and blue (B) are ejected. In an electrode material ejecting head for an electrode forming apparatus, a liquid-state electrode material is ejected, and in a bio-organic matter ejecting head for a chip manufacturing apparatus, a solution of bio-organic matter is ejected.

A plurality of nozzles, pressure chambers, one of which is formed for each nozzle, and a reservoir which is shared by the plurality of pressure chambers (also referred to as a common liquid chamber or a manifold) are provided inside the liquid ejecting head described above. Supply paths, which are formed to be narrower than the pressure chambers and which serve as channel resistance in relation to the liquid which flows into the pressure chambers, are formed in locations which communicate the reservoir with each of the pressure chambers (for example, refer to JP-A-2014-034114). The liquid ejecting head is configured to generate pressure fluctuation (a pressure change) in the liquid within the pressure chambers by the driving of piezoelectric elements (actuators), and to eject the liquid from the nozzles using the pressure fluctuation.

However, in the liquid ejecting head described above, when the pressure fluctuation is generated in the liquid within the pressure chambers, there is a counterflow of a portion of the liquid from the pressure chamber side to the reservoir side through the supply path. Due to the counterflow of a portion of the liquid, it may not be possible to eject the liquid from the nozzles by efficiently using the pressure fluctuation caused by the piezoelectric elements.

SUMMARY

An advantage of some aspects of the invention is to provide a liquid ejecting head capable of efficiently ejecting a liquid, and a manufacturing method of the liquid ejecting head.

According to an aspect of the invention, a liquid ejecting head includes a nozzle which ejects a liquid a pressure chamber, a portion of which is partitioned by a flexible diaphragm and which communicates with the nozzle, an actuator which is laminated on an opposite side of the diaphragm from the pressure chamber and changes a pressure within the pressure chamber, and a reservoir which communicates with the pressure chamber, in which a valve mechanism is provided in a region which is distanced from a region in which the actuator of the diaphragm is laminated, and is configured to allow the liquid to flow from the reservoir side into the pressure chamber side while inhibiting the liquid from flowing out from the pressure chamber side to the reservoir side.

In this case, it is possible to efficiently transmit the pressure change within the pressure chamber to the nozzle side when the liquid is ejected from the nozzle. As a result, it is possible to efficiently eject the liquid from the nozzle.

In the above configuration, it is preferable that the valve mechanism includes an opening which communicates the reservoir with the pressure chamber, and a valve receiving body which is provided in a position to mutually face the opening in the reservoir side, and it is preferable that, when an internal pressure of the pressure chamber rises relatively, an edge of the opening is elastically displaced to the reservoir side and inhibits the liquid from flowing out.

In this case, it is possible to simplify the configuration of the valve mechanism.

In this case, it is preferable that the edge of the opening and the valve receiving body overlap each other as viewed from a center axial direction of the opening of the diaphragm.

In this case, it is possible to more reliably prevent the flowing out of the liquid to the reservoir side.

In the configurations described above, it is preferable that at least a portion of the reservoir is partitioned by a portion which functions as a damper which absorbs a pressure change of the liquid within the reservoir.

In this case, it is possible to absorb the pressure change which occurs when the liquid is supplied into the reservoir.

According to another aspect of the invention, in a manufacturing method of a liquid ejecting head which includes a nozzle which ejects a liquid, a pressure chamber, a portion of which is partitioned by a flexible diaphragm and which communicates with the nozzle, an actuator which is laminated on an opposite side of the diaphragm from the pressure chamber and changes a pressure within the pressure chamber, a reservoir which communicates with the pressure chamber, and a valve mechanism which is provided in a region which is distanced from a region in which the actuator of the diaphragm is laminated, the method includes forming an opening in a region which is distanced from a region of the diaphragm in which the actuator is laminated, forming a valve receiving body in a region which overlaps the opening of the diaphragm in the reservoir side to interpose a thin film therebetween, and removing at least the thin film between the opening and the valve receiving body.

In this case, it is possible to easily form the valve mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

FIG. **1** is a perspective diagram illustrating the configuration of a printer.

FIG. **2**A is a cross sectional diagram illustrating the configuration of a recording head.

FIG. **2**B is an enlarged diagram illustrating region IIB.

FIG. **3** is a cross sectional diagram taken along line III-III in FIG. **2**B.

FIGS. **4**A and **4**B are schematic diagrams illustrating the operations of a valve mechanism.

FIGS. **5**A to **5**C are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism.

FIGS. **6**A to **6**C are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism.

FIGS. **7**A and **7**B are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism.

FIGS. **8**A and **8**B are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism.

FIG. **9**A is a cross sectional diagram illustrating the configuration of a recording head in a second embodiment.

FIG. **9**B is an enlarged diagram illustrating region IXB.

FIGS. **10**A and **10**B are schematic diagrams illustrating the operations of a valve mechanism in the second embodiment.

FIGS. **11**A to **11**C are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism in the second embodiment.

FIGS. **12**A to **12**C are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism in the second embodiment.

FIGS. **13**A and **13**B are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism in the second embodiment.

FIG. **14** is a cross sectional diagram illustrating the configuration of a recording head in a third embodiment.

FIG. **15** is a cross sectional diagram illustrating the configuration of a recording head in a fourth embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

Hereinafter, description will be given of the embodiments of the invention with reference to the attached drawings. Note that, in the embodiments described hereinafter, there are various limits as favorable embodiments of the invention; however, the scope of the invention is not limited thereto as long as there is no wording particularly limiting the invention in the description hereinafter. Hereinafter, an ink jet printer (hereinafter, a printer) with an ink jet recording head (hereinafter, a recording head), which is a type of the liquid ejecting head, mounted thereon will be described as an example of the liquid ejecting apparatus of the invention.

Description will be given of the configuration of a printer **1** with reference to FIG. **1**. The printer **1** is an apparatus which performs recording of an image or the like by ejecting a liquid-state ink onto the surface of a recording medium **2** (a type of landing target) such as recording paper. The printer **1** is provided with a recording head **3**, a carriage **4**, a carriage moving mechanism **5**, a transport mechanism **6**, and the like. The recording head **3** is attached to the carriage **4**, the carriage moving mechanism **5** causes the carriage **4** to move in a main scanning direction, and the transport mechanism **6** conveys the recording medium **2** in a sub-scanning direction. Here, the ink is a type of the liquid in the invention, and is stored in ink cartridges **7** which serve as liquid storage sources (liquid supply sources). The ink cartridges **7** are detachably mounted to the recording head **3**. Note that, a configuration may be adopted in which ink cartridges are disposed on a main body side of a printer, and an ink is supplied from the ink cartridges to a recording head through ink supply tubes.

The carriage moving mechanism **5** described above is provided with a timing belt **8**. The timing belt **8** is driven by a pulse motor **9** such as a DC motor. Accordingly, when the pulse motor **9** operates, the carriage **4** is guided by a guide rod **10** which is provided to span across the printer **1**, and moves reciprocally in the main scanning direction (the width direction of the recording medium **2**).

FIG. **2**A is a cross sectional diagram illustrating the configuration of the recording head **3**, and FIG. **2**B is an enlarged diagram illustrating region IIB in FIG. **2**A. FIG. **3** is a cross sectional diagram taken along line III-III in FIG. **2**B. Note that, in FIGS. **2**A and **2**B, the configuration of the main portions corresponding to another nozzle row is omitted due to being laterally symmetrical with the depicted configuration. As illustrated in FIG. **2**A, the recording head **3** in the present embodiment is provided with a pressure generation unit **14** and a channel unit **15**, and is configured to be attached to a head case **16** in a state in which the members are laminated together.

The head case **16** is a box-shaped member formed of a synthetic resin, and a reservoir **17** (also referred to as a common liquid chamber or a manifold) which supplies the ink to a plurality of pressure chambers **19** is formed inside the head case **16**. The ink which flows from the ink cartridges **7** into the recording head **3** is stored in the reservoir **17**. The reservoir **17** of the present embodiment is formed in the head case **16** with the bottom of the reservoir **17** in an open state, and is partitioned by the inner wall surfaces of the head case **16** and the top surface of a protective substrate (described later). The reservoir **17** is partitioned by a portion (a compliance portion) which functions as a damper which absorbs a pressure change of the ink within the reservoir **17**. In the present embodiment, the compliance portion is formed by an opening portion of the reservoir **17** to the side surfaces of the head case **16**, and sealing the opening with a flexible compliance sheet **18**. Note that, the compliance sheet **18** is formed of a hard substrate and film material laminated thereon, and is joined to the head case **16** from the film material side. A portion of the compliance sheet **18** which is formed by removing a portion of the substrate and leaving only the film material forms the compliance portion. Using the compliance portion, it is possible to absorb changes in pressure which occur when the ink is supplied into the reservoir **17**.

The pressure generation unit **14** forms a unit by a pressure chamber forming substrate **20** which forms the pressure chamber **19**, a diaphragm **24**, a piezoelectric element **26** (a type of actuator (pressure generating unit)), the protective substrate **27**, and the like being laminated together. The pressure chamber forming substrate **20** is formed of a silicon single crystal substrate, for example, and the plurality of pressure chambers **19** are formed to correspond to each nozzle **40** of a nozzle plate **39**. In the present embodiment, two rows of the nozzles **40** are formed on the nozzle plate **39**, and thus, there are two rows of the pressure chambers **19** corresponding to the respective nozzle rows formed on the pressure chamber forming substrate **20**. The pressure chamber **19** is a hollow portion which is long in the direction perpendicular to the direction in which the nozzles **40** are lined up, and extend from a position corresponding to the nozzle **40** to a position corresponding to the reservoir **17** at substantially the same width.

The diaphragm **24** (a type of flexible elastic film) is formed on the top surface of the pressure chamber forming substrate **20** (the surface of the opposite side from the joining surface with a communication substrate **41**) in a state in which the diaphragm **24** seals the opening in the top portion of the pressure chamber **19**. In other words, the top surface of the pressure chamber **19** is partitioned by the diaphragm **24**. For example, the diaphragm **24** is formed of silicon dioxide which is approximately 1 μm thick. As illustrated in FIG. **2**B, a plurality of openings **23** which penetrate the diaphragm **24** in the plate thickness direction thereof are formed in the end portion of the reservoir **17** side of the diaphragm **24** to correspond to each of the pressure chambers **19**. The opening **23** is a portion which forms a valve mechanism **21**, and detailed description will be given later. An insulating film **25** formed of zirconium oxide, for example, is formed in a region on top of the diaphragm **24** and distanced from the valve mechanism **21**. Specifically, as illustrated in FIG. **2**B, the insulating film **25** is formed in a region in which the piezoelectric element **26** is laminated and in the periphery of a valve space **22** in which the valve mechanism **21** is formed so as to avoid the valve mechanism **21**. The piezoelectric elements **26** are formed in positions corresponding to each of the pressure chambers **19** on the insulating film **25**.

The piezoelectric element **26** of the present embodiment is a so-called flexure mode piezoelectric element **26**. As illustrated in FIG. **2**B, the piezoelectric element **26** is formed by the sequential lamination of a bottom electrode film **29**, a piezoelectric layer **30**, and a top electrode film **31** on the insulating film **25** of the nozzle **40** side. In the present embodiment, whereas the bottom electrode film **29** is provided independently for each of the pressure chambers **19**, the top electrode film **31** is provided continually across the plurality of pressure chambers **19**. Therefore, the bottom electrode films **29** are individual electrodes for each of the pressure chambers **19**, and the top electrode film **31** is a common electrode which is shared by the pressure chambers **19**. The region in which the piezoelectric layer **30** is interposed between the bottom electrode film **29** and the top electrode film **31** is an active portion in which piezoelectric deformation occurs due to the application of a voltage between both electrodes. Note that, the bottom electrode film may be provided as a common electrode by forming the bottom electrode film continually across the plurality of pressure chambers, and the top electrode film may be provided as individual electrodes by providing the top electrode film independently for each of the pressure chambers. Various metals such as indium (Ir), platinum (Pt), titanium (Ti), tungsten (W), tantalum (Ta), and molybdenum (Mo), an alloy thereof, or the like may be used as the top electrode film **31** and the bottom electrode film **29**. $LaNiO_3$ is an example of an alloy electrode. A ferroelectric material such as lead zirconate titanate (PZT), a relaxor ferroelectric body obtained by adding a metal such as niobium, nickel, magnesium, bismuth or yttrium to the ferroelectric material, or the like may be used as the piezoelectric layer **30**. It is also possible to use a lead free material such as barium titanate as the piezoelectric layer **30**.

The bottom electrode film **29**, the piezoelectric layer **30**, and the top electrode film **31** are formed to surround the valve mechanism **21**, even in the periphery of the valve mechanism **21**. Accordingly, the valve space **22** is formed in the periphery of the valve mechanism **21** by partitioning. Since a plurality of the valve mechanisms **21** are formed to correspond to the plurality of pressure chambers **19**, a plurality of the valve spaces **22** are also formed to correspond thereto. Specifically, as illustrated in FIG. **2**B, the top electrode film **31** and the bottom electrode film **29**, which are electrically isolated from the top electrode film **31** and the bottom electrode film **29** of the piezoelectric element **26**, are formed in a position shifted closer to the valve mechanism **21** side than the piezoelectric element **26** to interpose the piezoelectric layer **30** which extends from the piezoelectric element **26**. The bottom electrode film **29**, the piezoelectric layer **30**, and the top electrode film **31** are also laminated on the opposite side from the piezoelectric element to interpose the valve mechanism **21**, and on both sides of the valve mechanism **21** in the nozzle row direction. Accordingly, the valve space **22** is formed in the periphery of the valve mechanism **21**. Note that, a voltage is not applied to the top electrode film **31** and the bottom electrode film **29** of the portions which partition the periphery of the valve space **22**. Therefore, the piezoelectric layer **30** interposed therebetween will not warp through intentional deformation.

As illustrated in FIG. **2**A, a common metal layer **33** which continues across the plurality of pressure chambers **19** is laminated in an end portion region of the piezoelectric element **26** in the longitudinal direction (the direction perpendicular to the nozzle row direction). The common metal layer **33** is formed of gold (Au), for example, and, as illustrated in FIG. **2**B, and is laminated on top of the top electrode film **31** via an adhesion layer **34** (a thin film in the invention) which is formed of titanium, nickel, chrome, an alloy thereof, or the like. The common metal layer **33** and the adhesion layer **34** of the present embodiment are formed on both end portions of the piezoelectric element **26** in the longitudinal direction, and in the periphery of the valve space **22**. The common metal layer **33** which is formed on the end portion of the nozzle **40** side of the piezoelectric element **26** is electrically connected to the top electrode film **31** and the bottom electrode film **29**, and, as illustrated in FIG. **2**A, extends past the end portion of the pressure chamber **19** (in detail, the top opening edge of the space which forms the pressure chamber) to a terminal region. The common metal layer **33** is electrically connected to electrode terminals of a wiring member (not shown) such as a flexible cable in the terminal region. Only the common metal layer **33** is partially formed in a position relative to the opening **23** of the diaphragm **24** within the valve space **22**. The portion of the common metal layer **33** is the portion which serves as a valve receiving body **32** of the valve mechanism **21**. Detailed description of the valve receiving body **32** will be given later.

The protective substrate **27** is disposed on top of the common metal layer **33**. Specifically, layers of the diaphragm **24**, the insulating film **25**, the bottom electrode film **29**, the piezoelectric layer **30**, the top electrode film **31**, the adhesion layer **34**, and the common metal layer **33** are laminated on the pressure chamber forming substrate **20**, and the bottom surface (the surface of the common metal layer **33** side) of the protective substrate **27** at which the plate thickness is the greatest is joined to the top of the common metal layer **33**. Note that, the protective substrate **27** is made of, for example, glass, ceramic material, silicon single crystal substrate, metal, or a hard member of synthetic resin or the like. A concave portion **37**, which is formed at a size at which the driving of the piezoelectric element **26** is not inhibited, is formed in a region of the protective substrate **27** facing the active portion of the piezoelectric element **26**. In the protective substrate **27**, a plurality of communication paths **28**, which penetrate the protective substrate **27** in the plate thickness direction, are formed to correspond to the plurality of lined up pressure chambers **19** in positions corresponding to the valve spaces **22**. The top end of the communication path **28** communicates with the reservoir **17**, and the bottom end of the communication path **28** communicates with the pressure chamber **19** via the valve mechanism **21**. Unlike the supply path of the related art which communicates between the reservoir and the pressure chamber, the communication path **28** is configured to reduce the channel resistance as much as possible. In other words, the supply path of the related art is designed to have a predetermined channel resistance by being formed with a narrower width than the pressure chamber; however, in the recording head **3** of the present embodiment, since the communication path **28** includes the valve mechanism **21**, it is not necessary to provide the channel resistance, and the communication path **28** is formed such that, for example, the cross-sectional area of the communication path **28** is greater than or equal to the cross-sectional area of the pressure chamber **19**. Note that, with regard to the communication path **28**, it is also possible to configure the communication path **28** as a channel which is shared by the pressure chambers as a portion of the reservoir without partitioning the communication path **28** for each pressure chamber.

The channel unit **15** includes the communication substrate **41** which is joined to the bottom surface of the pressure chamber forming substrate **20** and the nozzle plate **39** which is joined to the bottom surface of the communication substrate **41**. A plurality of the nozzles **40** are open in the nozzle plate **39** in a straight line formation (row formation). The plurality of lined up nozzles **40** are provided at an equal interval along the sub-scanning direction which is perpendicular to the main scanning direction from the nozzle **40** of one end side to the nozzle **40** of the other end side at a pitch (for example, 180 dpi) corresponding to the dot formation density. In the present embodiment, two nozzle rows are formed on the nozzle plate **39**. The communication substrate **41** partitions the bottom surface of the pressure chamber **19** by sealing the bottom opening of the pressure chamber **19**. Nozzle communication paths **42** which communicate between the nozzles **40** and the pressure chambers **19** are provided in the communication substrate **41** to line up in a straight line formation at the same pitch as the nozzles **40**. Note that, the nozzle **40** and the nozzle communication path **42** are formed on the end portion of the opposite side from the valve mechanism **21** side of the pressure chamber **19** in the longitudinal direction of the pressure chamber **19**. The head case **16** is joined to the top surface of the communication substrate **41** closer to the outside than the pressure generation unit **14** in a state of housing the pressure generation unit **14** therein.

Next, description will be given of the valve mechanism **21**. As described above, the valve mechanism **21** is provided in a region which is distanced from the region in which the piezoelectric element **26** of the diaphragm **24** is laminated, and is configured to allow the ink to flow from the reservoir **17** side into the pressure chamber **19** side while inhibiting the ink from flowing out from the pressure chamber **19** side to the reservoir **17** side. Specifically, as illustrated in FIG. 2B, the valve mechanism **21** includes an opening **23** and a valve receiving body **32**. The opening **23** is formed in the diaphragm **24** in the valve space **22** and communicates the reservoir **17** with the pressure chamber **19** via the communication path **28** and the valve space **22**, and the valve receiving body **32** is provided in a position to face the opening **23** mutually in the reservoir **17** side and is formed of a portion of the common metal layer **33**. As described above, since the diaphragm **24** is flexible, the edge of the opening **23** of the diaphragm **24** functions as a valve body which is displaced according to variation in the internal pressure of the pressure chamber **19**. As illustrated in FIG. **3**, the valve receiving body **32** of the present embodiment is formed in the shape of a bridge which extends in the nozzle row direction in the center of the valve space **22** and functions as a valve seat in relation to the edge of the opening **23**. The opening **23** of the diaphragm **24** is formed to be a size smaller than the valve receiving body **32**. In other words, in plan view (as viewed from a center axial direction of the opening **23** of the diaphragm **24**), the edge of the opening **23** of the diaphragm **24** and the valve receiving body **32** are formed so as to overlap each other. As illustrated in FIG. 2B, the portion of the valve receiving body **32** which overlaps the diaphragm **24**, that is, the edge of the valve receiving body **32** is depressed to the reservoir **17** side by the thickness of the diaphragm **24**, and is distanced from the diaphragm **24** by leaving a gap equal to the thickness of the adhesion layer **34** in a state in which the diaphragm **24** is not displaced (a non-flexing state).

In the valve mechanism **21** which is formed in this manner, when the internal pressure of the pressure chamber **19** rises relatively due to the driving of the piezoelectric element **26**, as illustrated in FIG. **4**A, the edge of the opening **23** of the diaphragm **24** is elastically displaced to the reservoir **17** side, abuts the valve receiving body **32**, and enters an open-valve state, thereby inhibiting the flowing out of the ink from the pressure chamber **19** side to the reservoir **17** side. Meanwhile, when the internal pressure of the pressure chamber **19** drops relatively due to the driving of the piezoelectric element **26**, as illustrated in FIG. **4**B, the edge of the opening **23** of the diaphragm **24** is elastically displaced to the pressure chamber **19** side, releases the abutting state between the diaphragm **24** and the valve receiving body **32** (the edge of the opening **23** is distanced from the valve receiving body **32**), and enters a closed-valve state. Accordingly, the flowing of the ink from the reservoir **17** side into the pressure chamber **19** side is allowed. In other words, due to providing the valve mechanism **21**, the channel resistance in relation to the ink which flows out from the pressure chamber **19** side to the reservoir **17** side is greater than the channel resistance in relation to the ink which flows from the reservoir **17** side into the pressure chamber **19** side.

Here, with regard to the dimensions of the opening **23**, it is preferable to satisfy the following expression (1) when wa is the width of the valve receiving body **32** (the dimension in a direction perpendicular to the extending direction of the valve receiving body **32**) and wb is the width of the opening **23** (the dimension in a direction perpendicular to the extending direction of the valve receiving body **32**).

$$wa \geq wb \tag{1}$$

Accordingly, when the internal pressure of the pressure chamber **19** rises relatively, it is possible to more reliably inhibit the flowing out of the ink from the pressure chamber **19** side to the reservoir **17** side.

It is preferable to satisfy the following expression (2) when ha is the length of the valve receiving body **32** (the dimension in the extending direction of the valve receiving body **32**), and hb is the length of the opening **23** (the dimension in the extending direction of the valve receiving body **32**).

$$ha \geq hb \tag{2}$$

Accordingly, when the internal pressure of the pressure chamber **19** rises relatively, it is possible to more reliably inhibit the flowing out of the ink from the pressure chamber **19** side to the reservoir **17** side.

In the recording head **3** which is formed in this manner, the pressure in the pressure chamber **19** is caused to drop by driving the piezoelectric element **26**, and the ink is taken into the pressure chamber **19** from the reservoir **17** via the valve mechanism **21**. Subsequently, the pressure in the pressure chamber **19** is raised by driving the piezoelectric element **26**.

Using the rise in pressure, the ink within the pressure chamber **19** is ejected from the nozzle **40** via the nozzle communication path **42**.

In the recording head **3** in the invention, since the valve mechanism **21** is provided between the reservoir **17** and the pressure chamber **19**, it is possible to suppress the counter-flow of the ink to the reservoir **17** side when the pressure in the pressure chamber **19** is raised. Accordingly, it is possible to efficiently transmit the rise in pressure in the pressure chamber **19** to the nozzle **40** side, and it is possible to efficiently eject the ink from the nozzle **40**. As a result, it is possible to reduce the pressure change which is generated by the piezoelectric element **26** which is necessary to eject a fixed amount of the ink. Accordingly, it is possible to reduce the size of the piezoelectric element **26** (the active portion), and thus it is possible to reduce the size of the recording head **3**. By reducing the size of the piezoelectric elements **26**, it is possible to reduce the pitch at which the piezoelectric elements **26** are provided to line up. In other words, it is possible to reduce the pitch at which the nozzles **40** are provided to line up. Accordingly, since it is possible to reduce the pitch at which the nozzles are formed, higher definition printing becomes possible, and it is possible to improve the quality of the printing. It is possible to lower the voltage which is applied to the piezoelectric element **26**, and the reliability of the recording head **3** is improved.

In the related art, the supply path which acts as a channel resistance and has a narrower width than the pressure chamber is formed between the reservoir and the pressure chamber; however, since it is not necessary to form such a supply path, it is possible to further reduce the size of the recording head **3**. Since the pressure change which is generated in the pressure chamber **19** during the ejection of the ink does not easily transmit to the reservoir **17** side due to the valve mechanism **21**, it is possible to reduce the area of the portion (the compliance portion) which is provided in the reservoir **17** and which functions as a damper which absorbs the pressure change. In other words, in the compliance portion, an area may be secured at which it is possible to suppress the pressure change within the reservoir **17** which is generated when the ink within the reservoir **17** is supplied to a range which causes no problems in the specification of the product, and it is possible to reduce the size of the compliance portion as much as possible within the range. Accordingly, it is possible to further reduce the size of the recording head **3**. Since the valve mechanism **21** is formed of the opening **23** of the diaphragm **24** and the valve receiving body **32** which is provided in a position to face the opening **23** mutually in the reservoir **17** side, it is possible to simplify the configuration of the valve mechanism **21**. Since the edge of the opening **23** and the valve receiving body **32** overlap each other as viewed from a center axial direction of the opening **23** of the diaphragm **24**, it is possible to more reliably prevent the flowing out of the ink to the reservoir **17** side.

Next, description will be given of the manufacturing method of the recording head **3** which includes the valve mechanism **21** described above. FIGS. **5**A to **8**B are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism **21**. In the present embodiment, rises in the manufacturing cost caused by an increase in the number of processes are suppressed by sharing the majority of the processes of forming the valve mechanism **21** with the processes of forming the diaphragm, the piezoelectric element, and the common metal layer of the related art. Note that, in the following manufacturing method, description is given with the main focus on the valve mechanism **21**.

Specifically, first, as illustrated in FIG. **5**A, the diaphragm **24** and the insulating film **25** are laminated, in this order, on the pressure chamber forming substrate **20** (in detail, the substrate which serves as the pressure chamber forming substrate **20**, for example, a silicon single crystal substrate). As illustrated in FIG. **5**B, the bottom electrode film **29** is formed as a film on the insulating film **25**, and a portion which serves as the common electrode of the piezoelectric element **26** is patterned using wet etching or dry etching. Next, as illustrated in FIG. **5**C, the piezoelectric layer **30** is formed as a film, a portion of the piezoelectric layer **30** is removed using wet etching or dry etching such that portions which serve as the piezoelectric elements **26** and the periphery of a portion which serves as the valve space **22** remain. Subsequently, as illustrated in FIG. **6**A, the top electrode film **31** is formed as a film, a portion of the top electrode film **31** is removed using wet etching or dry etching such that portions which serve as individual electrodes of the piezoelectric elements **26** and the periphery of a portion which serves as the valve space **22** remain. Accordingly, the piezoelectric element **26** is formed.

If the piezoelectric element **26** is formed, as illustrated in FIG. **6**B, the insulating film **25** and the bottom electrode film **29** of a portion which serves as the valve space **22** which is formed in a region distanced from the region in which the piezoelectric element **26** is laminated are removed using wet etching or dry etching. Next, as illustrated in FIG. **6**C, the opening **23** is formed by partially removing the diaphragm **24** within the valve space **22** using wet etching or dry etching and penetrating the diaphragm **24** in the thickness direction. Here, the opening **23** of the diaphragm **24** is formed smaller than the portion of the insulating film **25** and the bottom electrode film **29** within the valve space **22** which is removed. Subsequently, as illustrated in FIG. **7**A, the adhesion layer **34** and the common metal layer **33** are formed as a film in this order, portions of the adhesion layer **34** and the common metal layer **33** are removed using wet etching or dry etching such that both end portions of the piezoelectric element **26** in the longitudinal direction, the periphery of the valve space **22**, and the portion which serves as the valve receiving body **32** remain. Accordingly, the valve receiving body **32** is formed in a region of the diaphragm **24** which overlaps the opening **23** in the reservoir **17** side so as to interpose the adhesion layer **34**. Here, the valve receiving body **32** and the adhesion layer **34** on which the valve receiving body **32** is laminated are patterned to be slightly larger than the opening **23** so as to cover the opening **23** of the diaphragm **24**. Next, as illustrated in FIG. **7**B, the protective substrate **27** is joined to the common metal layer **33** from the top surface side using an adhesive or the like. Accordingly, the communication path **28** of the protective substrate **27** and the valve space **22** are communicated with each other. Note that, a protective film **43** is bonded to a surface of an opposite side of the protective substrate **27** from the surface which is joined to the common metal layer **33**.

If the protective substrate **27** is joined, as illustrated in FIG. **8**A, the pressure chamber **19** is formed by wet etching the substrate which serves as the pressure chamber forming substrate **20** from the surface of the opposite side from the diaphragm **24**. At this time, since the protective film **43** is bonded to the protective substrate **27**, the etching liquid entering the piezoelectric element **26** side from the protective substrate **27** side is suppressed. The protective film **43** is removed after the wet etching which forms the pressure chamber **19** ends. Subsequently, as illustrated in FIG. **8**B, at least the adhesion layer **34** between the opening **23** and the valve receiving body **32** is removed by wet etching using an etching liquid which removes only the adhesion layer **34**. Accordingly, a gap is formed between the valve receiving body **32** and the diaphragm **24**. In this manner, the pressure generation unit **14** which includes the valve mechanism **21** is formed. Finally, the recording head **3** which includes the valve mechanism **21** is created by joining the channel unit **15** to the pressure generation unit **14** from the bottom surface side (the pressure chamber forming substrate **20** side), and by joining the head case **16** to the pressure generation unit **14** from the top surface side (the protective substrate **27** side).

In this manner, since the manufacturing method of the recording head **3** in the invention includes a process in which the opening **23** is formed in a region which is distanced from the region in which the piezoelectric element **26** of the diaphragm **24** is laminated, a process in which the valve receiving body **32** is formed to interpose the adhesion layer **34** in a region which overlaps the opening **23** in the reservoir **17** side of the diaphragm **24**, and a process in which at least the adhesion layer **34** between the opening **23** and the valve receiving body **32** is removed, it is possible to easily form the valve mechanism **21**.

Incidentally, the configuration in which the valve mechanism is provided in a region which is distanced from the region which is between the reservoir and the pressure chamber and in which the piezoelectric element of the diaphragm of the recording head is laminated is not limited to the embodiment described above. In the second embodiment illustrated in FIGS. **9**A and **9**B, the valve mechanism **46** is formed on the bottom side (the opposite side from a pressure chamber **19'**) of a communication substrate **41'**.

FIG. **9**A is a cross sectional diagram illustrating the configuration of a recording head **3'** in the second embodiment, and FIG. **9**B is an enlarged diagram illustrating region IXB in FIG. **9**A. As illustrated in FIG. **9**A, the recording head **3'** in the present embodiment is also provided with a pressure generation unit **14'** and a channel unit **15'**, and is configured to be attached to a head case **16'** in a state in which the members are laminated together.

As opposed to in the first embodiment described above, no reservoir is formed on the inner portion of the head case **16'** of the present embodiment, and, as illustrated in FIG. **9**A, a liquid supply path **44** which supplies the ink to the reservoir **45** is formed on the inner portion of the head case **16'**. The ink which flows from the ink cartridges **7** into the recording head **3'** flows into the reservoir **45** which is positioned below the head case **16'** via the liquid supply path **44**.

In the same manner as in the first embodiment described above, the pressure generation unit **14** forms a unit by a pressure chamber forming substrate **20'**, a diaphragm **24'**, a piezoelectric element **26'**, a protective substrate **27'**, and the like being laminated together; however, the valve mechanism is not provided. In other words, an opening is not provided in the diaphragm **24'** which partitions the top surface of the pressure chamber forming substrate **20'**, and the valve space is not formed. Therefore, the opening of the top portion of the pressure chamber **19'** is sealed by the diaphragm **24'** without gaps. In other words, in the present embodiment, the piezoelectric element **26'** is formed on the diaphragm **24'** of the pressure chamber **19'** via an insulating film **25'**, and a common metal layer **33'** is formed on both end portions in the longitudinal direction on the piezoelectric element **26'** via an adhesion layer (not shown). The protective substrate **27'** is joined onto the common metal layer **33'**.

In addition to a nozzle plate **39'** and the communication substrate **41'**, the channel unit **15'** of the present embodiment is provided with a reservoir part **48** in which the reservoir **45** is formed and the valve mechanism **46**. A nozzle communication path **42'** which communicates between the nozzle **40'** and the pressure chamber **19'** is formed in the communication substrate **41'** in the same manner as in the first embodiment. Additionally, a pressure chamber communication path **49** and a reservoir communication path **50** are formed in the communication substrate **41'** of the present embodiment. The pressure chamber communication path **49** is a channel which communicates between the reservoir **45** and the pressure chamber **19'**, and is formed between the reservoir communication path **50** and the nozzle communication path **42'**. The top end of the pressure chamber communication path **49** is open to the pressure chamber **19'** at the end portion of the opposite side from the nozzle communication path **42'** side of the pressure chamber **19'**. The bottom end of the pressure chamber communication path **49** is open to the reservoir **45** at the end portion of the opposite side from the reservoir communication path **50** side. The reservoir communication path **50** is a channel which communicates between the liquid supply path **44** and the reservoir **45**, and is formed in a position corresponding to the liquid supply path **44**. Note that, the nozzle plate **39'** of the present embodiment is formed as small as possible, and is joined to the communication substrate **41'** closer to the inside thereof than the reservoir part **48**.

The reservoir part **48** is a substrate to which a compliance sheet **18'** is joined from below, and is joined to the bottom surface side of the communication substrate **41'** closer to the outside than the nozzle plate **39'**. The reservoir **45** which supplies the ink to the plurality of pressure chambers is formed on the inner portion of the reservoir part **48**. The reservoir **45** is shaped such that the top and bottom are open (that it, has a shape penetrated in the thickness direction), and is formed by the top being sealed by the communication substrate **41'** (in detail, the communication substrate **41'** in which an elastic substrate **51**, an intermediary layer **52**, and a valve receiving body forming substrate **53** (described later) are laminated on the bottom surface side of the communication substrate **41'**) and the bottom being sealed by the compliance sheet **18'**. A portion (a compliance portion) which functions as a damper which absorbs a pressure change of the ink within the reservoir **45** is formed below the reservoir part **48** by the compliance sheet **18'**. According to the present embodiment, in the same manner as the embodiment described above, it is possible to reduce the area of the portion (the compliance portion) which functions as a damper. Note that, the reservoir part **48** may be formed of a single substrate, and may be formed by laminating a plurality of substrates together. For example, when the reservoir part is formed of a plurality of substrates, it is possible to form the compliance portion in the middle of the reservoir part by inserting a compliance sheet in the middle of the plurality of substrates.

As illustrated in FIG. **9**B, the elastic substrate **51**, the intermediary layer **52**, and the valve receiving body forming substrate **53** are laminated between the reservoir part **48** and the communication substrate **41'**. Specifically, the elastic substrate **51**, the intermediary layer **52**, and the valve receiving body forming substrate **53** are laminated in order from the bottom surface side of the communication substrate **41'**. The elastic substrate **51**, the intermediary layer **52**, and the valve receiving body forming substrate **53** are layers for forming the valve mechanism **46**. The elastic substrate **51** is a flexible substrate (a film), and is formed of silicon dioxide which is approximately 1 μm thick, for example. The intermediary layer **52** is formed of titanium, nickel, chrome, an alloy thereof, or the like, and improves the adherence (adhesion) between the elastic substrate **51** and the valve receiving body forming substrate **53**. Additionally, it is possible to use a resin, an adhesive, or the like as the intermediary layer **52**. The valve receiving body forming substrate **53** is formed of a metal such as gold (Au), for example. Note that, an opening (omitted from the drawing) for communicating between the reservoir communication path **50** and the reservoir **45** is formed in a location corresponding to the reservoir communication path **50** in the elastic substrate **51**, the intermediary layer **52**, and the valve receiving body forming substrate **53**.

As illustrated in FIG. **9**B, the valve mechanism **46** is formed between the pressure chamber communication path **49** and the reservoir **45**. Specifically, the valve mechanism **46** includes an opening **54** and a valve receiving body **55**. The opening **54** is formed in the elastic substrate **51** and communicates the pressure chamber **19'** (the pressure chamber communication path **49**) with the reservoir **45**, and the valve receiving body **55** is provided in a position to mutually face the opening **54** in the reservoir **45** side and is formed of the valve receiving body forming substrate **53**. The valve receiving body **55** is provided within a valve space **47** which is formed by removing the valve receiving body forming substrate **53** of a region corresponding to the pressure chamber communication path **49**. In other words, the valve receiving body **55** is formed by penetrating a portion of a region corresponding to the pressure chamber communication path **49** of the valve receiving body forming substrate **53** other than the portion corresponding to the opening **54** of the elastic substrate **51** in the plate thickness direction. In the same manner as in the first embodiment described above, the valve receiving body **55** of the present embodiment is formed in the center of the valve space **47** to extend in the nozzle row direction. The opening **54** of the elastic substrate **51** is formed a size smaller than the valve receiving body **55**. In other words, in plan view (as viewed from a center axial direction of the opening **54** of the elastic substrate **51**), the edge of the opening **54** of the elastic substrate **51** is formed to overlap the valve receiving body **55**. Note that, the valve receiving body **55** and the elastic substrate **51** are distanced by leaving a gap equal to the thickness of the intermediary layer **52** in a state in which the elastic substrate **51** is not displaced (a non-flexing state). Note that, since the other configuration is the same as that of the first embodiment described above, description thereof will be omitted.

Even with the valve mechanism **46** of the present embodiment, it is possible to allow the ink to flow from the reservoir **45** side into the pressure chamber **19'** side while inhibiting the ink from flowing out from the pressure chamber **19'** side to the reservoir **45** side. In other words, when the internal pressure of the pressure chamber **19'** rises relatively due to the driving of the piezoelectric element **26'**, as illustrated in FIG. **10**A, the edge of the opening **54** of the elastic substrate **51** is elastically displaced to the reservoir **45** side, abuts the valve receiving body **55**, and enters a closed-valve state, thereby inhibiting the flowing out of the ink from the pressure chamber **19'** side to the reservoir **45** side. Meanwhile, when the internal pressure of the pressure chamber **19'** drops relatively due to the driving of the piezoelectric element **26'**, as illustrated in FIG. **10**B, the edge of the opening **54** of the elastic substrate **51** is elastically displaced to the pressure chamber **19'** side, valve opens to release the space between the elastic substrate **51** and the valve receiving body **55**, and allows the flowing of the ink from the reservoir **45** side into the pressure chamber **19'** side. In other words, due to providing the valve mechanism **46**, the channel resistance in relation to the ink which flows out from the pressure chamber **19'** side to the reservoir **45** side is greater than the channel resistance in relation to the ink which flows from the reservoir **45** side into the pressure chamber **19'** side.

Note that, even in the present embodiment, it is preferable to satisfy the following expression (1) when wa is the width of the valve receiving body **55** (the dimension in a direction perpendicular to the extending direction of the valve receiving body **55**) and wb is the width of the opening **54** (the dimension in a direction perpendicular to the extending direction of the valve receiving body **55**).

$$wa \geq wb \tag{1}$$

Accordingly, when the internal pressure of the pressure chamber **19'** rises relatively, it is possible to more reliably inhibit the flowing out of the ink from the pressure chamber **19'** side to the reservoir **45** side.

It is preferable to satisfy the following expression (2) when ha is the length of the valve receiving body **55** (the dimension in the extending direction of the valve receiving body **55**), and hb is the length of the opening **54** (the dimension in the extending direction of the valve receiving body **55**).

$$ha \geq hb \tag{2}$$

Accordingly, when the internal pressure of the pressure chamber **19'** rises relatively, it is possible to more reliably inhibit the flowing out of the ink from the pressure chamber **19'** side to the reservoir **45** side.

In the recording head **3'** of the present embodiment, since the valve mechanism **46** is provided between the reservoir **45** and the pressure chamber **19'**, it is possible to suppress the counterflow of the ink to the reservoir **45** side when the pressure in the pressure chamber **19'** is raised. Accordingly, it is possible to efficiently transmit the rise in pressure in the pressure chamber **19'** to the nozzle **40** side, and it is possible to efficiently eject the ink from the nozzle **40**. As a result, it is possible to reduce the pressure change which is generated by the piezoelectric element **26'** which is necessary to eject a fixed amount of the ink. Accordingly, it is possible to reduce the size of the piezoelectric element **26'** (the active portion), and thus it is possible to reduce the size of the recording head **3'**. By reducing the size of the piezoelectric elements **26'**, it is possible to reduce the pitch at which the piezoelectric elements **26'** are provided to line up. In other words, it is possible to reduce the pitch at which the nozzles **40'** are provided to line up. Accordingly, higher definition printing becomes possible, and it is possible to improve the quality of the printing. It is possible to lower the voltage which is applied to the piezoelectric element **26'**, and the reliability of the recording head **3'** is improved.

Even in the present embodiment, since it is not necessary to form the supply path between the reservoir and the pressure chamber as in the related art, it is possible to further reduce the size of the recording head **3'**. Since the pressure change which is generated in the pressure chamber **19'** during the ejection of the ink does not easily transmit to the reservoir **45** side due to the valve mechanism **46**, it is possible to reduce the area of the portion (the compliance portion) which is provided in the reservoir **45** and which functions as a damper which absorbs the pressure change. Accordingly, it is possible to further reduce the size of the recording head **3'**. Since the valve mechanism **46** is formed of the opening **54** of the elastic substrate **51** and the valve receiving body **55** which is provided in a position to face the opening **54** mutually in the reservoir **45** side, it is possible to simplify the configuration of the valve mechanism **46**. Since the edge of the opening **54** and the valve receiving body **55** overlap each other as viewed from a center axial direction of the opening **54** of the elastic substrate **51**, it is possible to more reliably prevent the flowing out of the ink to the reservoir **45** side.

Next, description will be given of the manufacturing method of the recording head **3'** which includes the valve mechanism **46** of the present embodiment. FIGS. **11**A and **13**B are diagrams of a state transition in cross section which illustrate the manufacturing process of the valve mechanism **46** in the present embodiment. Note that, in the following manufacturing method, description is given with a main focus on the valve mechanism **46**.

As illustrated in FIG. **11**A, the elastic substrate **51** is formed as a film on the bottom surface of the communication substrate **41'** (in detail, the substrate which serves as the communication substrate **41'**, for example, a silicon single crystal substrate). Next, as illustrated in FIG. **11**B, the opening **54** is formed by removing a portion of the elastic substrate **51** using wet etching or dry etching. As illustrated in FIG. **11**C, the intermediary layer **52** is formed as a film on the bottom surface side of the communication substrate **41'** on which the elastic substrate **51** is laminated. As illustrated in FIG. **12**A, the valve receiving body forming substrate **53** is formed as a film on the bottom surface side of the intermediary layer **52**.

If the valve receiving body forming substrate **53** is laminated on the communication substrate **41'** via the intermediary layer **52**, the communication substrate **41'** is etched using the BOSCH method or the like, and, as illustrated in FIG. **12**B, the pressure chamber communication path **49** is formed. Note that, at this time, the nozzle communication path **42'**, the reservoir communication path **50**, and the like are also formed at the same time. As illustrated in FIG. **12**C, the valve receiving body **55** and the valve space **47** are formed by removing a portion of the valve receiving body forming substrate **53** and the intermediary layer **52** from the bottom surface side using wet etching or dry etching. Subsequently, as illustrated in FIG. **13**A, at least the intermediary layer **52** between the opening **54** and the valve receiving body **55** is removed by wet etching using an etching liquid which removes only the intermediary layer **52**. Accordingly, the valve receiving body **55** is separated from the elastic substrate **51**. In this manner, the valve mechanism **46** is formed. As illustrated in FIG. **13**B, if the valve mechanism **46** is formed, the reservoir part **48** is joined to the valve receiving body forming substrate **53** from the bottom surface side. The nozzle plate **39'** is joined to the communication substrate **41'** from the bottom surface side, and the channel unit **15'** is created. Finally, the recording head **3'** which includes the valve mechanism **46** is created by joining the pressure generation unit **14'** and the head case **16'** to the channel unit **15'** from the top surface side.

Note that, in the second embodiment described above, the communication substrate is formed using a single substrate; however, it is also possible to form the communication substrate using a plurality of substrates. When the communication substrate is formed using a plurality of substrates, the valve mechanism may be formed on the bottom surface of the communication substrate, and may be formed in the middle of the communication substrate (that is, the pressure chamber communication path) in the plate thickness direction. When the valve mechanism is formed in the middle of the pressure chamber communication path in the plate thickness direction, the elastic substrate, the intermediary layer, and the valve receiving body forming substrate are laminated between vertically adjacent substrates of the plurality of substrates which form the communication substrate.

In the first and second embodiments, in a state in which the diaphragm or the elastic substrate are not displaced, the diaphragm or the elastic substrate of the edge of the opening is distanced from the valve receiving body; however, the invention is not limited thereto, and it is also possible to configure the diaphragm or the elastic substrate not to be distanced. That is, when the internal pressure of the pressure chamber drops relatively, the diaphragm or the elastic substrate of the edge of the opening may be displaced to the pressure chamber side, and may permit the flowing in of the ink from the reservoir side to the pressure chamber side.

In the first and second embodiments described above, the manufacturing process of the valve mechanism is described as the manufacturing method of the recording head; however, the invention is not limited thereto. In the manufacturing method described above, it is possible to use the manufacturing process of the valve mechanism as the manufacturing method of the valve mechanism. For example, it is possible to adapt the manufacturing process of the valve mechanism for the manufacturing method of a valve mechanism which is provided in something other than the recording head described above.

Incidentally, in the first embodiment described above, the communication substrate **41** is laminated between the pressure chamber forming substrate **20** and the nozzle plate **39**; however, the invention is not limited thereto. In the third embodiment illustrated in FIG. **14**, the communication substrate is not provided, and the nozzle plate **39** is joined to the pressure chamber forming substrate **20**. In other words, the opening of the bottom portion of the pressure chamber **19** is sealed by the nozzle plate **39**. The nozzle **40** communicates directly with the end portion of the opposite side from the valve mechanism **21** side of the pressure chamber **19** in the longitudinal direction of the pressure chamber **19**. The head case **16** is joined to the nozzle plate **39** further outside than the pressure generation unit **14** of the top surface of the nozzle plate **39**. Note that, since the other configuration is the same as that of the first embodiment described above, description thereof will be omitted.

In this manner, since the communication substrate is not provided in the present embodiment, the number of manufacturing processes of the recording head **3** is reduced. Accordingly, it is possible to reduce manufacturing costs. It is possible to reduce the thickness of the recording head **3** by an amount equal to the thickness of the communication substrate, and it is possible to further reduce the size of the recording head **3**.

In the second embodiment described above, the nozzle plate **39'** is joined to the bottom surface of the communication substrate **41'** closer to the inside than the reservoir part **48**; however, the invention is not limited thereto. In the fourth embodiment illustrated in FIG. **15**, the nozzle plate **39'** is joined to the bottom surface of the reservoir part **48**. Specifically, the reservoir part **48** extends further inside than a position corresponding to the nozzle communication path **42'**, and the nozzle plate **39'** is joined to the portion of the inside of the reservoir part **48**. Note that, together with the reservoir part **48**, the elastic substrate **51**, the intermediary layer **52**, and the valve receiving body forming substrate **53** extend further inward than a position corresponding to the nozzle communication path **42'**. The compliance sheet **18'** is provided on the outside of the nozzle plate in a region corresponding to the reservoir **45**. Note that, it is possible to adopt a configuration in which the compliance sheet **18'** extends further inward than a position corresponding to the nozzle communication path, in the same manner as the reservoir part **48**. A through hole **57** which communicates the nozzle communication path **42'** with the nozzle **40'** is formed in a position corresponding to the nozzle communication path **42'** of the reservoir part **48**, and openings (omitted from the drawings) are also formed in the same position in the elastic substrate **51**, the intermediary layer **52**, and the valve receiving body forming substrate **53**. Note that, since the other configuration is the same as that of the second embodiment described above, description thereof will be omitted.

In this manner, since the nozzle plate **39'** is formed below the reservoir part **48**, for example, when the bottom surface of the nozzle plate **39'** is wiped by a wiper (not shown), it is possible to suppress the occurrence of a problem in which the wiper is inhibited from abutting the nozzle plate **39'** by the reservoir part **48**. Accordingly, it is possible to more reliably wipe the bottom surface of the nozzle plate **39'** with the wiper.

In the embodiments described above, an ink jet recording head which is mounted to an ink jet printer is exemplified; however, as long as the piezoelectric element and the pressure chamber of the configurations described above are present, it is possible to apply the invention to an apparatus which ejects a liquid other than ink. For example, it is possible to apply the invention to a color material ejecting head which is used in the manufacture of a color filter of a liquid crystal display or the like, an electrode material ejecting head which is used in forming electrodes of an organic electro luminescence (EL) display, a face emission display (FED), and the like, a bio-organic matter ejecting head used in the manufacture of bio chips (biochemical elements), and the like.

What is claimed is:

1. A liquid ejecting head, comprising:
a nozzle which ejects a liquid;
a pressure chamber, a portion of which is partitioned by a flexible diaphragm and which communicates with the nozzle;
an actuator which is laminated on the flexible diaphragm and changes a pressure within the pressure chamber; and
a reservoir which communicates with the pressure chamber,
wherein a valve mechanism is provided in a region which is distanced from a region in which the actuator of the diaphragm is laminated, and is configured to allow the liquid to flow from the reservoir side into the pressure chamber side while inhibiting the liquid from flowing out from the pressure chamber side to the reservoir side,
wherein the valve mechanism is laminated over a surface of a pressure chamber forming substrate forming the pressure chamber.

2. The liquid ejecting head according to claim **1**,
wherein the valve mechanism includes an opening which communicates the reservoir with the pressure chamber, and a valve receiving body which is provided in a position to mutually face the opening in the reservoir side, and
wherein, when an internal pressure of the pressure chamber rises relatively, an edge of the opening is elastically displaced to the reservoir side and inhibits the liquid from flowing out.

3. The liquid ejecting head according to claim **2**,
wherein the edge of the opening and the valve receiving body overlap each other as viewed from a center axial direction of the opening of the diaphragm.

4. The liquid ejecting head according to claim **1**,
wherein at least a portion of the reservoir is partitioned by a portion which functions as a damper which absorbs a pressure change of the liquid within the reservoir.

5. A manufacturing method of a liquid ejecting head which includes
a nozzle which ejects a liquid,
a pressure chamber, a portion of which is partitioned by a flexible diaphragm and which communicates with the nozzle,
an actuator which is laminated on an opposite side of the diaphragm from the pressure chamber and changes a pressure within the pressure chamber,
a reservoir which communicates with the pressure chamber, and
a valve mechanism which is provided in a region which is distanced from a region in which the actuator of the diaphragm is laminated, the method comprising:
forming an opening in a region which is distanced from a region of the diaphragm in which the actuator is laminated;
forming a valve receiving body in a region which overlaps the opening of the diaphragm in the reservoir side to interpose a thin film therebetween; and
removing at least the thin film between the opening and the valve receiving body to form the valve mechanism which is laminated over a pressure chamber forming substrate forming the pressure chamber.

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